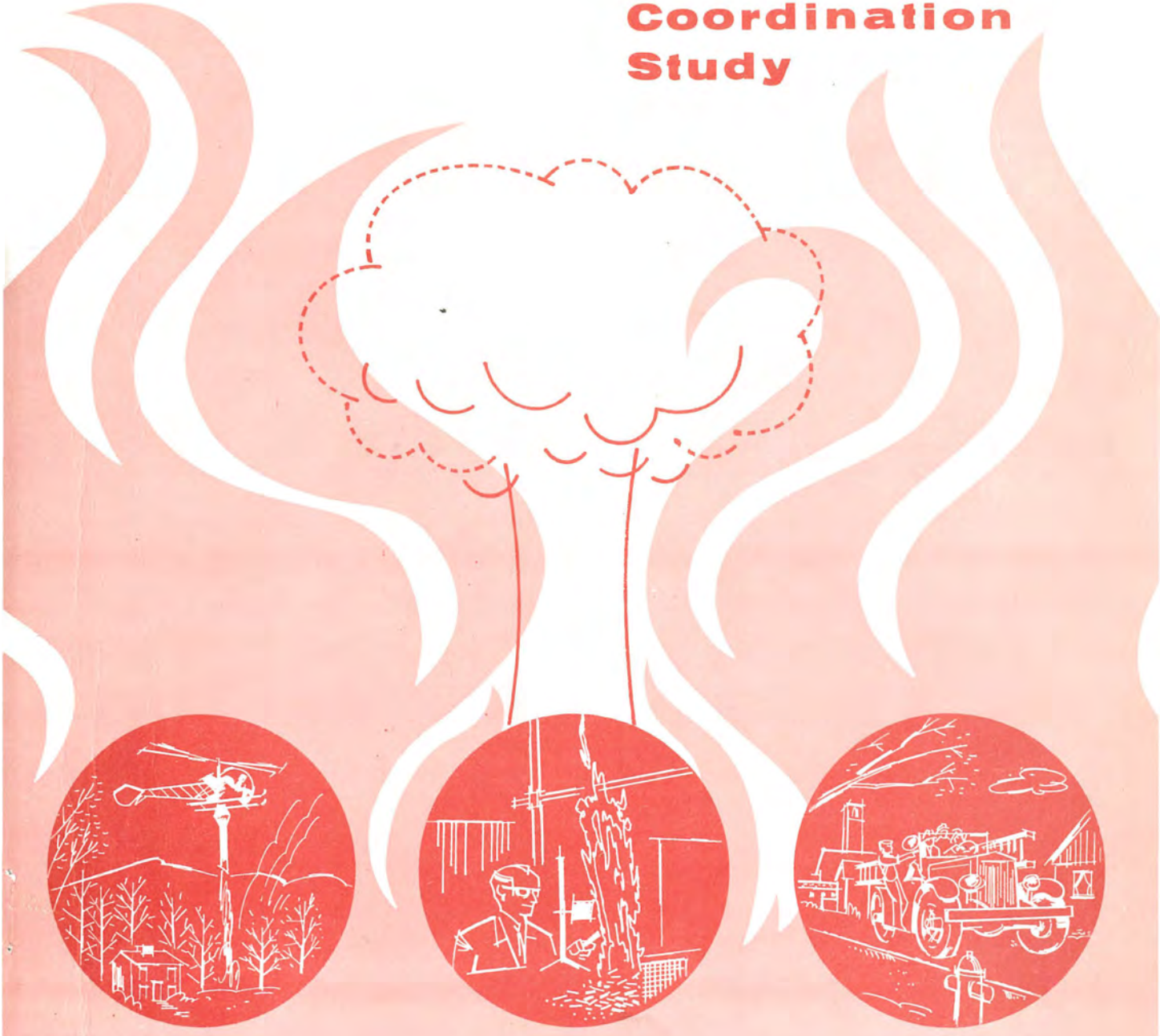
COMBINED FIRE ANALYSIS

National Fire Coordination Study



U.S. DEPARTMENT OF AGRICULTURE/FOREST SERVICE/DIVISION OF FIRE CONTROL

COMBINED FIRE ANALYSIS

Report By

John H. Dieterich

Reviewed by:

William R. Moore
Theodore G. Storey
Merle S. Lowden

Fires Studies:

Deadwood Fire, Nevada Fires,
Park Headquarters Fire, and
Santa Rosa Fires

Prepared by the U. S. Department of Agriculture, Forest Service, Division of Fire Control, National Fire Coordination Study, Washington, D. C. for the Office of Civil Defense under contract OCD-PS-64-229.

CONTENTS

	Page
INTRODUCTION	1
THE PROBLEM	2
OBJECTIVE	3
ANALYSIS	4
CONCLUSIONS	6
RECOMMENDATIONS	12
APPENDIX	17

INTRODUCTION

The Forest Service is currently conducting a National Fire Coordination Study for the Office of Civil Defense, Office of the Secretary of the Army. The objective of the study is to recommend to OCD how to most effectively join Federal, State, local, and private fire forces to handle fire emergencies resulting from enemy attack. Resolving problems of this magnitude and developing workable arrangements that are effective nation-wide requires the assistance of fire services and top-level fire managers from all parts of the country.

We are examining our effectiveness by studying what actually happens on large fires. Typical large fires do not present as severe a fire problem as would a nuclear attack, but here we examine reality--see how our mutual aid works, how command assignments are made, how our equipment is applied, how people were evacuated, what tactics worked best, etc. Then we can relate what we learn to the more serious nuclear attack fires and accompanying fallout problems.

Large fires will be studied and analyzed throughout this project. We have studied four large fires or groups of fires, thus far. These are described in detail in the Analysis section. This paper relates the conclusions and recommendations of the four fires studied and combines these into a single report. Later on, we will study some purely urban fires. Lack of opportunity and time prevented this during the first phase of the study.

THE PROBLEM

The National Fire Coordination team will prepare an analytical report for OCD in which feasible alternative courses of action will be recommended. Cost-effectiveness and impact analyses will be made on each of the recommended alternatives.

The alternative courses of action will be developed through synthesis and analysis of the following data:

1. Results of pertinent research.
2. Findings from review of pertinent literature.
3. Ideas and suggestions developed at the fire service briefing meetings.
4. Findings and conclusions from mutual aid and command studies.
5. Findings and conclusions from the study of large fires.
6. Effects of possible nuclear attack on fire resources.

This paper is concerned with item 5. The problem is to analyze the findings and conclusions, identify common problems, isolate successful practices so that the results may be used to develop feasible alternative directions for the OCD fire program.

OBJECTIVES

The objectives of this report are to:

1. Provide a summary of data from the four study fires.
2. Identify factors that are common to the success, or failure, of the fire suppression organization to effectively handle the fire emergency.
3. Develop conclusions or assumptions which are pertinent to the National Fire Coordination Study.
4. Make recommendations that can be used in the National Fire Coordination Study.

ANALYSIS

Four fires were studied. They provide a cross-section of fuel types, land values, and degree of fire organization complexity and involvement from which conclusions and recommendations can be made. Additional study fires are needed to verify these findings and identify others.

Table 1 summarizes and compares individual items that are of particular interest to this study. The basis for these comparisons are observations, interviews, and written material secured during the course of study for each of the four fires. Descriptions are necessarily brief, but provide a relative picture of the factors that are important from the standpoint of a nationally coordinated fire control effort.

TABLE 1

SUMMARY OF STUDY FIRES

TABLE 1
SUMMARY OF STUDY FIRES

STUDY ITEMS	DEADWOOD FIRE	PARK HEADQUARTERS FIRE	NEVADA FIRES	SANTA ROSA FIRES
GENERAL				
Values threatened	Very high (town)	Mod-High (Nat'l Park)	Moderate (Blgds)	Very high (town, ranches houses,
Emergency declared	Yes (Gov.)	No	Yes (Gov.)	Yes (Gov.)
Multiple fires	Yes (three)	No	Yes (six)	Yes (three)
Fuel type (predom.)	Timber	grass-scatt. tbr.	grass, brush	brush, timber
Weather	Critical: Low RH Cold front, Wind shift	Critical: High winds low R.H.	Critical: High winds, low RH	Critical: Strong winds, low RH
COMMAND				
Central command	Yes-but delayed	Yes	Yes-on Indiv. fires and Fire Coord. Center.	Yes: on each of 3 fire
Coordination (all agencies)	Poor (too late)	Poor (too late)	Poor(too late)	Good
MUTUAL AID				
Mutual aid in effect	Yes	Yes	Yes	Yes
Coop agreement	Yes	Yes	Yes	Yes
FIRE SUPPRESSION				
Independent action	Yes	Yes	Yes	Yes
Ind. Action effective	Yes	Partial success	Mostly ineffective	Partial success
Suppression methods	Pumpers, hand, air attack	Pumpers, hand, air attack	Dozers, pumpers, air attack	Mostly pumpers, air attack
Outside crews	Yes: Indians other Regions	Yes: Indians, military	Yes: Indians, military	Yes: Inmate crews
Equipment Shortages	Yes-hand tools	No	Yes-heavy equip.	Yes-pumpers
Manpower shortages	No	Yes-early	Yes	Yes
PRE-EMERGENCY PLANS				
Aid to Control of Fire	Yes	Yes	Yes	Yes
Resource inventory	Adequate for Ave. fire	Adequate for ave. fire	Inadequate for mult. fires	Inadequate for mult. fire
Evacuation	Yes-effective	No	No	Yes-effective
Training(in-service)	Tactics: Yes Command: Yes	Tactics: Yes Command: Yes	Tactics: Yes Command: Yes	Tactics: Yes Command: Yes
Training (joint)	Tactics: Yes Command: Some	Tactics: Yes Command: Some	Tactics: Yes Command: No	Tactics: Yes Command: Some
Known point to activate coop. action	Yes	Yes	No	Yes
CIVIL DEFENSE PARTICIPATION	Not coordinated available	No	No	CD units used effectively
COMMUNICATIONS				
Adequate for normal	Yes	Yes	Yes	Yes
Adequate for this disaster	No	Yes	No	No
Command frequency	No	No	No	No
Mobile Communication Center	No	Yes	Yes	Yes

CONCLUSIONS

These conclusions summarize some of the successful practices that were evident or observed on the four fires.

1. Effective initial independent action can be cited on all four fires. Trained individuals acting on their own can be reasonably effective in handling limited fire suppression activities until a central command is established. Untrained individuals acting independently are much less effective and may even jeopardize their own safety as well as effective control action by fire suppression agencies.

2. Men and equipment may be moved effectively from long distances to assist in fire suppression activities.

3. Civil Defense fire suppression equipment can be effectively joined with existing fire agencies to strengthen the overall suppression forces.

4. Communication centers may function adequately for single large fire disasters, but tend to break down during multiple large fire emergencies.

5. Aircraft can be used with a varying degree of success on all fires - even to help protect structures that are threatened by fire. Both fixed-wing aircraft and helicopters are useful. Strong winds limit the use of both types of aircraft for short periods.

6. The fire agencies that maintaine an up-to-date pre-emergency resource inventory of available men and equipment are most successful in handling the large fire situations.

7. The most successful coordination of fire suppression effort appears to be between agencies that have made a regular practice of training together to handle cooperative fires - both large and small.

8. Successful evacuation proceeded for public buildings, both hospitals, on the two fires where organized evacuation was needed. (Deadwood and Santa Rosa). The citizens of Deadwood evacuated readily when the fire threatened the town, but many individuals on the Santa Rosa fires chose to remain and attempt to save their houses - which they did in many instances.

These conclusions suggest problems that, if solved, would strengthen a nationally coordinated fire effort.

1. More detailed pre-emergency planning is needed for large fire emergencies that are more severe than have been experienced in the past. Pre-emergency planning is usually deficient in one or more of the following respects:

   a. resource inventories are not complete.
   b. command responsibilities not well defined.
   c. deficient in joint training efforts.
   d. no provisions made for operational testing of cooperative organizations.

2. Quick establishment of a strong central command should be emphasized. Urban fires rarely present such a problem because the general limits of the fire are predictable. This might not hold true of fires resulting from nuclear attack. Predicting ultimate fire size on wildlands, and hence the suppression forces needed to control the fire, is more difficult. Overhead and crews must frequently come from long distances to supplement initial attack forces. Volunteers, both trained and untrained, may go to work on a fire without reporting to fire headquarters, and leave without being released by fire headquarters. Command and coordination was most effective when all agencies involved were represented by liaison at an established fire headquarters.

3. Better coordination of effort is needed between the fire services and the Civil Defense organization. Frequently the two groups come together only during a fire emergency and as a result the capabilities of both agencies are not fully realized.

4. Training of Citizens and Volunteers: "It should be recognized that the populace that is being sheltered and protected is in itself a resource." (Nevada Fires, 1964, by J. W. Jay). More effective use of this resource needs to be made wherever possible.

5. Adequate communications were a problem on all four study fires. The three most common problems in order of importance appeared to be (1) overloading of available frequencies, (2) various frequencies not adequately tied together, and (3) lack of uniform procedure and terminology. Poor communications resulted in inadequate dispatch and control of crews on all four fires. A nuclear attack would likely pose two separate yet related communication problems: (1) extreme demands upon the communication net of the fire services, and (2) similar demands on the EOC net that coordinates all the public services. We need to decide how far the fire services should develop their net and at what point they'll rely on the EOC net.

6. As a result of one fire, extensive hazard reduction measures were taken in a nearby community in an effort to prevent a similar situation from developing. These efforts may have been effective for a short time, and may well still be effective - or a more critical fuel situation may have developed. More information is needed on the effectiveness of such measures.

7. Equipment shortages were experienced on all fires. Some equipment used is not commonly employed. In most instances the shortages were in the types of equipment most commonly used on the fire. (pumpers and hand tools)

8. The occurrence of multiple fires create problems of shortages and delays in placing both men and equipment on going fires. One large fire is usually handled more effectively than two fires in close proximity totalling approximately the same acreage.

9. Fire situation strategic and tactical scouting and intelligence will present a serious problem following a nuclear attack. Present day organization and methods are inadequate for the larger conflagrations.

10. Resource locator and dispatching systems are barely adequate for the worst situations typically experienced by a community. These are inadequate for a nuclear disaster.

11. Pre-emergency plans and training should be problem-oriented, i.e., define the problem that might occur, consider the capabilities and potential capabilities available, then plan, organize, and train to use these fully, to cope with the problem. I.e., if city firemen should fight both brush and urban fires, then they should be so trained. (See Exhibit B, Appendix).

12. Frequent joint involvement in minor emergencies of the fire services, other mutual aid sources, and civil defense coordinators, strengthens abilities to act effectively in a severe emergency.

RECOMMENDATIONS

1. Recognize that independent action by volunteers will be a common occurrence on surburban and wildland fires. Moreover, independent action to control small fires following a nuclear attack might be a most effective action. Recommend rudimentary training for this labor source to make their efforts more effective on both structure and wildland fires. Training should prepare individuals to act effectively and prepare a cadre of people to supervise small fire suppression teams.

2. Recommend a uniform policy to concerning prompt establishment of a central command on all fires. This would include instructions for both trained and volunteer firefighters to make early contact with fire headquarters and operate under a central command.

3. Recognize that network overloading will occur and seek ways to operate without communications at certain levels of command.

4. Recognize that better utilization of existing system is possible through more uniform and efficient operating practices.

5. Seek to improve existing system to handle disaster situations by improving equipment and adding emergency frequencies.

6. Tie the fire control communication system in with the over-all net that coordinates all of the public services. The total system must be capable of: (1) providing positive communications between fireline, headquarters, mutual aid partners, and the coordination center, and (2) coordinating all public services to fully utilize them in the disaster.

7. Consider a special study to solve the planning, organizing, and implementing problems of communications. This problem is broader than the fire services.

8. Plan maximum use of aircraft for damage assessment, fire mapping, and for intelligence purposes during both urban and wildland conflagrations.

9. Use aircraft for fire protection and suppression on both urban and wildlands. Investigate possible night use of aircraft for fire suppression.

10. Consider establishing disaster stockpiles of both common and specialized equipment that could be used locally or quickly transported by air to other parts of the country.

11. Increase quantity of equipment, particularly pumpers, in certain areas to handle peacetime fire disasters.

12. Consider a general policy of transporting top level command individuals or teams to fire emergencies in various parts of the country.

13. Establish a more uniform policy concerning preparation and implementation of Pre-Emergency Plans. Such plans should not be limited to the more complex fire agencies and should include adequate preparation of plans by small groups. (See Recommendations in the Nevada Fire Study, Exhibit C, Appendix).

14. CD coordinate the Pre-Emergency Planning dealing with mass fires or large fire disasters. OCD should give guidance in the form of samples and policy.

15. Establish standards for using hazard reduction measures and a system of fuel breaks on both urban and wildlands to protect both personal, public property, and establish shelters during natural fires or nuclear attack fires.

16. Establish central command early as the most effective approach to handling fire disasters.

17. Encourage independent action in the early stages of a fire, but that efforts be quickly coordinated with the command center when it is established. Include this in command training.

18. Consider the use of Zone Coordination Centers - these may be pre-designated Emergency Operating Centers--for assemblying and dispatching equipment and manpower over a broad area.

19. Conduct more localized command and staff training. Train the people together that will work together in disasters. This will be more effective if accompanied by arranging like duties for like jobs. (See Exhibit C, Appendix). Simulate real conditions.

20. Intensify pre-emergency inventories of equipment, manpower, and fire potential. These should include estimates of fire tools readily available "off the shelf" in store and on jobs.

21. Prepare an evacuation enforcement policy, i.e., under what conditions should the fire services force people to abandon their homes. Such a policy could minimize conflicting instructions between fire, police and others.

22. Develop a standard nationwide fire terminology glossary.

23. Pre-plan fire control action in enough detail so individual fire service units, supporting units and key members of the public, will take effective action in the absence of communications. Support this with training and drills.

24. Design an effective way to gather information about the fire situation following a disaster. As a minimum, this should include: (1) a description of who is responsible for what phase of situational scouting, (2) implementing present knowledge in the infra-red detection and mapping field.

25. Organize Emergency Operating Centers (command and coordinating centers) so that all agencies apt to be involved in a disaster are represented by liaison.

26. Train key firemen how to organize, train, and use civilians effectively in emergencies.

27. Develop or adapt a standard nationwide radio operating procedures handbook for the fire services. Train all operators.

28. Consider a special project to develop a resource locator and dispatching system.

29. Rearrange OCD policy, if necessary, to encourage CD participation in non-declared emergencies. These to provide training, practice, and readiness for more serious emergencies.

APPENDIX

Exhibit A — Conclusions and Recommendations from Deadwood Fire Report.

Exhibit B — Conclusions and Recommendations from Park Headquarters Fire.

Exhibit C — Conclusions and Recommendations from Nevada Fires.

Exhibit D. — Conclusions and Recommendations from Santa Rosa Fires

Exhibit E — Description of Fires Analyzed.

Exhibit A - Conclusions and Recommendations

From Deadwood Fire

CONCLUSIONS

From the analysis of the Deadwood Fire, we can conclude or assume the following:

A. Independent action by individuals familiar with the use of hand tools and mechanical equipment was reasonably effective in accomplishing short-term, specific objectives.

B. Independent action, though sometimes effective, is also dangerous if not directed or coordinated.

C. Fire suppression was made more difficult because of inadequate scouting and intelligence.

D. As a result of the Deadwood Fire the Homestake Mining Company took action to reduce the fire hazard around the town of Lead and the mine installations.

E. Evacuation of small communities can be accomplished in an orderly manner during periods of stress.

F. Utility crews were effective in handling the emergencies that were produced as a result of the Deadwood Fire.

G. Central command was established within the first two hours, but recognition of this central command was not complete. Even after several hours, crews were moved independently without consent form fire headquarters.

H. The wearing of "Two Hats" by public officials during emergency situations often means that one responsibility suffers while administering the other.

I. Civil Defense equipment and supplies were not adequately tied into local command.

J. Fire suppression efforts by the Forest Service within the Exemption Area are supported by a fee system. This appears to be a workable arrangement.

K. Air attack was more effective when pilots were given specific instructions on where to drop.

L. Unauthorized aircraft flying around the fire created hazards to aerial fire suppression activities.

M. We assume that the existing mine supervisory organization acted as overhead for some of the independent action and were moderately successful in handling these initial attack crews.

N. Communications, were generally good but some lack of coordination occurred because of communication gaps.

RECOMMENDATIONS

These recommendations are concerned with problems, that if solved, would increase effectiveness and contribute toward a nationally coordinated fire system.

A. Continue to work with, and train, local individuals to act as temporary or permanent fire overhead.

B. Inventory available personnel that are working in organized labor, and have the stamina and training to work effectively in fire control.

C. Include a description of who is responsible for what phase of situation scouting in disaster planning.

D. Design an effective way to gather information about the fire situation following a disaster. Project Fire Scan is likely to be an important part of this.

E. Design an interagency communications system that will help achieve a unified central command rapidly following a disaster.

F. Coordinate Civil Defense and fire services so that fire defense utilizes the capabilities of both during a disaster.

G. Study the possibilities of effective use of aerial delivery of fire retardants in urban conflagration.

H. Develop ways to control unauthorized aircraft in disaster areas.

I. Include representatives from law enforcement agencies in the annual pre-disaster planning and joint training meetings to coordinate their activities with emergency efforts.

These recommendations are concerned with strong points that could be adapted to an effective nationally coordinated fire system.

A. Design ways to train or otherwise build upon the capabilities of individuals to act independently to suppress fires -- while at the same time recognizing the need for a central command to eventually control the disaster.

B. Plan and carry out fuel reduction projects in situations where communities are bordered by hazardous rural fuels. This is especially important in nuclear target areas.

C. Organize and train selected individuals (civilian, public) so they can assemble and effectively lead small fire crews following a disaster.

Exhibit B Conclusions and Recommendations

Park Headquarters Fire

CONCLUSIONS

From the analysis of what happened on the "Park Headquarters" Fire, we can assume or conclude the following:

1. Mutual aid arrangements in this area are based on formal written agreements that describe in detail the responsibilities of the cooperating agencies and the conditions under which they will operate.

2. Pre-emergency resource inventory and pre-disaster planning would make it possible to assemble 4,000-6,000 men under a major disaster situation within one to two hours. Most of these men would be drawn from distances up to 150 miles in the Black Hills.

3. Frequent, past large fires have provided an opportunity to "test" the workings of the cooperative fire agreements, and have resulted in an improvement of existing mutual aid arrangements.

4. The joint meeting of fire agencies held annually to review the cooperative agreement and mutual aid and command practices, keeps the agreement current and strengthens working relations between agencies.

5. There is a mutual feeling of respect between fire agencies. Command assignments are made to the most qualified persons without fear of criticism.

6. Fuel, type, relative humidity, and wind were the primary factors influencing spread of the fire. There was also a significant difference in character of fire spread on protected lands in the Park, as opposed to fires spreading on heavily grazed ranch lands adjacent to the Park.

7. The National Park Service does not support an elaborate fire control organization on park lands - instead they rely on the other suppression organizations to handle the large fires that occur within the Park boundaries.

8. Air attack was credited with helping save some Park Service improvements in the very early stages of the fire.

9. The use of co-fire bosses on this fire was effective because it provided the Park Service (the responsible agency) with a means of helping to make command decisions on a fire of their responsibility--even though the Forest Service had been asked to manage the fire.

10. More effective command would have been achieved if there had been representatives from both the State Park and State Forestry fire control organizations at fire headquarters during the early stages of the fire.

11. Communications were adequate, except that more effective control of State crews would have been possible had there been a State radio and liaison at fire headquarters early in the afternoon.

RECOMMENDATIONS

A. Procedures, policies and practices which show promise for adapting to a nationally coordinated fire service are:

1. Independent, initial action, followed by rapid control of the fire suppression effort through central command can be used effectively in the early stages of a fire, providing the independent initial action is pre-planned for maximum effectiveness.

2. With adequate pre-disaster mutual aid planning, an effective source of manpower and equipment can be assembled from outside the disaster area.

3. Frequent involvement in large fires or other minor disaster situations, should tend to strengthen the organization in time of major disaster. This may suggest the Civil Defense policies should encourage participation in day-to-day emergencies.

B. These problems observed on the "Park Headquarters" Fire, if solved, would increase the effectiveness of a nationally coordinated fire system:

1. In order for the command function to be more effective in the early stages of a project fire, all fire control agencies involved should be represented by liaison at an established fire headquarters at the earliest possible time.

2. A communications system needs to be developed that will be: (1) capable of providing positive communications between fire-line, headquarters, and organization, engaged in mutual support, and (2) capable of handling multiple large fire emergencies.

3. The differences in fire spread between the lightly grazed park lands and the heavily grazed private ranch lands suggest that studies be made to map or otherwise identify fuel conditions adjacent to major target areas for purposes of modifying fuels to lessen fire spread.

C. Additional recommendations pertinent to Project 229:

1. During natural disaster situations, or large fire emergencies much can be accomplished through a planned program of independent action. Eventually a central command must be established, but more reliance may have to be placed on a conditioned-response by individuals.

2. Provide additional training for volunteer or rural fire defense crews that would stress more effective independent action on all fires.

Exhibit C Conclusions and Recommendations from Nevada Fires

CONCLUSIONS

It can be concluded or assumed that:

A. Pre-emergency planning aided in effective control of the fire. It made possible the mobilization of control forces within hours. Pre-emergency plans would have been more effective if completely coordinated effort had been implemented sooner and more thoroughly.

Pre-emergency plans would have been more effective if they had stated specifically how to coordinate the effort of cooperating agencies, as the fire emergency became more serious. The plan would have been more effective if it had said what to do, who should do it, and how to go about it.

B. Arranging like duties in like positions for fire overhead in each fire service or agency will make mutual aid more effective. (Similar job qualification standards.)

C. It is helpful if fire control forces use a common terminology and nomenclature, and similar radio operating procedures. (Communications, both hardware and language.)

D. Pre-emergency, joint training aided in control of the fire. Efforts of cooperating agencies would have been more effective if joint pre-emergency training had gone further. It should include organization for project-size fires, coordination, and stress.

E. Pre-emergency training of fire control personnel in how to organize and train private citizens, would have made the citizens' efforts more effective.

F. Men and equipment could have been used more effectively if there was an adequate dispatching and locator system available.

G. Initiative in tactics and strategy by fire overhead was a factor in control of the fires. Uncommon equipment was pressed into service. There was bold burning out of firelines.

Control efforts would have been more effective if the best tools for the job had been available and skillfully applied. Tractor-plow units could have built line in much of this terrain and soil and at a much faster rate.

RECOMMENDATIONS

These recommendations, developed from our analysis and conclusions, are especially significant to achieving an effective nationally coordianted fire capability:

A. Pre-emergency Planning. Pre-emergency planning is a necessity. These plans should include:

1. Definition of mutual aid areas; such as the boundary of metropolitan areas, a county, a State, or a compact of States. This area would be a coordinated unit at a described level of emergency. Certain suppression forces, if not all forces therein, would be available for use anywhere in the area.

2. Definition of the coordinating method, such as:
   (a) Selection of the coordinator and his team members (in advance).
   (b) Statements of their authority and responsibility.
   (c) List of overhead positions to be filled, and the job descriptions of each.
   (d) Selection of headquarters and/or alternates.
   (e) Communications plans
   (f) Alternates and alternatives.

3. Definition of values within the area, and guides to establishing priorities.

4. Description of hazards in the area; fuels, risk, and breaks.

5. Description of fire fighting forces available. Include information as to mobility and use. Include detail where needed, such as how to organize and to operate an air tanker attack.

6. Definition of when the emergency plans should go into effect. The occurrence of certain events would activate the plan. For example, any one of the following events could be the "trigger".
   (a) A four-alarm fire.
   (b) The occurrence of multiple fires under conditions that make it immediately obvious that the responsible agencies cannot get control.
   (c) Fires burning out of control into the second day.
   (d) Fires occurring from enemy action within the area.
   (e) A threat of disaster. (See Appendix, Exhibit I, Nevada suggestion.)

B. Uniform Job Descriptions. Two key tasks that will clarify responsibilities, reduce stress, promote effectiveness, and provide training objectives are:

1. Develop uniform overhead position descriptions.
2. Develop uniform job qualification standards.

C. Uniform Procedures. Uniformity in language, terminology, and radio operating procedure should be provided for speed, clarity, and better understanding. This applies between all fire services, urban, rural, and forest. These two tasks are especially important:

1. Develop a fire services glossary.
2. Develop a radio operating procedures handbook.

D. Training. Pre-emergency, joint training of fire services personnel should be conducted. Training should be current. It should include elements such as organizing for a large fire situation, coordinating of forces, decision-making, allowing for the fatigue factor. Use of the fire control training Simulator shows promise here.

E. Use of Private Citizens. It should be recognized that the populace that is being sheltered and protected, is in itself a resource. Fire control personnel can be prepared to train and supervise the public in doing effective work during an emergency. Training tasks could include:

1. Avoiding the hazards connected with fire.
2. Suppression tactics, small fires.
3. Survival and recovery.
4. Aid to the very old and the very young.
5. The protection of food and water.
6. The clearing of debris.
7. Traffic control.

F. Resource Locator System. A development project is indicated for a dispatching and locator system. The first step is a staff effort to establish criteria and write a statement of need.

G. Selection and Use of Proper Equipment. Air transport of specialized heavy equipment, such as tractor-plow units, should be considered. The expense may be justified to get the right tool for the job and to get it in time.

Exhibit D Conclusions and Recommendations
from Santa Rosa Fires

CONCLUSIONS

1. The trio of fires got as large as they did primarily because of the unprecedented strong and persistent winds early Monday morning and on Tuesday and Wendesday. Persistently low humidities and low fuel moistures contributed to rapid fire spread.
2. The synoptic weather pattern that produced the extreme spread conditions was not unusual. The fact that the pattern persisted in the fire area for as long as it did and produced winds as strong as it did was quite unusual.
3. The fire services did not believe that such a disaster could happen to them. They hever expected the adverse weather conditions to last for as long as they did. For these reasons the fire services probably could be considered to have been somewhat unprepared for what happened.
4. There were many instances of shortages of equipment and manpower and of tardy arrivals of these forces. These factors undoubtedly contributed to more acres being lost and, possibly, more structures being burned than would otherwise have been the case. However, it is difficult to assign numbers to these effects.

5. In all fairness to the C.D.F. and C.D.O. it should be pointed out that most shortages and delays were attributable to the drain on resources caused by the numerous contemporary fires burning in the same general area. There simply wasn't enough men and equipment to go around.

6. The strong winds and turbulence also contributed indirectly to the fires getting large by keeping the air tankers, lead planes and helicopters grounded during the fires' biggest runs and urban threat.

7. In general, the mutual aid system functioned smoothly on the fires. Requests for assistance through C.D.O. were filled quickly and adequately in most instances.

8. Problems in the mutual aid area involved mostly equipment deficiencies and lack of proper training among the responding forces.

   a. Units from some cities lacked adequate tank capacity to fight fires effectively in rural areas.

   b. Many units were limited in where they could operate because they lacked four-wheel drive.

   c. Topless cabs on some trucks seriously exposed the operators to heat, flame, and firebrands when working in tight situations such as protecting individual structures.

   d. In general, operators on the city units were not trained to fight forest fires. This reduced their effectiveness. Specifically, they didn't understand the need for mopup and how to go about it, nor did they understand how to patrol fireline.

9. It is doubtful if air attack could have stopped or materially slowed up any of the fires during their big runs. However, air drops might have been able to protect individual structures had the aircraft been able to fly. After the winds subsided, air drops saved some structures in the hills near Santa Rosa and in Boyes Hot Springs. The air tankers were very effective when they could operate.

10. Lack of radio communications between units dispatched under mutual aid and the C.D.F. materially decreased the effectiveness of the responding units. Without communications, these units could not readily be moved about to best advantage by the fire commander, nor could they be warned if they were being threatened by the fire.

11. Some responding units simply packed up and went home when it appeared to them that the fire threat was over. This was due primarily to lack of communications. Lack of a basic understanding of forest fire behavior was a contributing factor.

12. Some responding units failed to check in with the dispatcher upon arrival and before departure. This occurred at the height of the fire threat to Santa Rosa. They simply drove out to the fire and pitched in and left when, in their opinion, the fire threat was over.

13. People (citizens) will take independent action in fire emergencies to meet the common threat. There were many examples in the present emergency.

14. The Santa Rosa Hospital was saved by massing pumpers near the structure, wetting it down and pumping on the fire.

15. Nearly 300 structures were lost, but probably three times this number, and, possibly, entire cities were saved by effective control action. The pumpers were especially effective protecting structures.

16. Fatigue among top command, particularly the fire bosses, was a problem, but this was overcome by rotating command.

RECOMMENDATIONS

1. Strengthen research on forecasting weather patterns associated with large fires.
2. Strengthen research on predicting local winds associated with these weathern patterns.
3. Make mandatory the preparation and use of fire behavior forecasts on large fires and on fires with potential for becoming large.
4. Establish inter-agency training in combatting mass fire disasters including training on actual mock fire field problems. This will be expensive, but it is vital that we do this if we hope to be able to handle nuclear fire disasters.
5. Invistigate ways to eliminate jamming of communication systems, particularly radio, during large fire emergencies. Solutions might include providing more frequencies, restricting traffic, and developing alternate means of communications.
6. Increase the number of fire pumpers equipped to fight rural fires. These should be under the jurisdiction of C.D.O. The September 1964 fire disasters demonstrated the need for more equipment.
7. Equip new pumpers with four-wheel drive, large tank capacity, closed cabs, and make provision for drafting water.
8. Study the feasibility of conducting air attack at night. This might necessitate developing means for dropping containers of water from safe altitudes using explosive charges equipped with proximity fuses to disperse the water.

9. Organize and conduct joint training exercises in disaster fire control among all fire services, including mock field fires.
10. Assign to C.D.O. or O.C.D. the responsibility for formulating and supervising these exercises and preparing training plans. A supervisor should be named to coordinate this training. All fire services should have advisory responsibility.
11. Give city firemen who are subject to call on rural fires under mutual aid training in rural fire fighting.
12. Study the effect of fatigue factors on the efficiency of fire overhead and command.

Exhibit E Description of Fires Analyzed

The following four fires form the basis for this report. The name, date, location, and size, the agency responsible for control and cooperating agencies are listed.

Past fire:

Deadwood Fire - September 8-9, 1959

Deadwood, South Dakota
4501 Acres
Black Hills National Forest (State of South Dakota, Rural Fire Departments, City Fire Departments, Regions 1 and 2, USFS)

This fire burned under extreme weather conditions, twice threatened the town of Deadwood, and eventually burned more than $1 million in structures and improvements. While this fire was burning, another fire started only 11 miles away that was potentially as bad as the Deadwood fire.

Current fires:

Nevada Fires - August 16-21, 1964

Elko, Nevada
278,159 Acres
Bureau of Land Management (State of Nevada, U. S. Forest Service)

Lightning started 35 fires in the vicinity of Elko, Nevada and six major fires resulted. Low relative humidity and strong erratic winds and flash fuels caused large area involvement and control difficulties.

Park Headquarters Fire - September 2-3, 1964

Wind Cave National Park, South Dakota
12,000 Acres
National Park Service (State of South Dakota,
U. S. Forest Service, Rural Fire Departments)

The Park Headquarters Fire was typical of a wind driven fire in light fuels. The fire spread so rapidly that a coordinated initial attack was not possible - some crews went to work to protect National Park improvements while volunteer crews started work on other portions of the fire.

Santa Rosa Fires - September 19-27, 1964

Santa Rosa, Calistoga, Napa, and Boyes Hot Springs, California
71,531 Acres
California State Division of Forestry (California Disaster Office, Municipal Fire Department, Volunteer Fire Departments)

An extended period of critical weather, coupled with numerous fire starts - some of these incendiary resulted in a multiple fire situation that burned nearly 300 structures in wildlands and urban areas. Due to the fire load in this area and in other parts of the state, there was a shortage of men and equipment needed to cope with the situation.